HYDROGEN PEROXIDE (H_2O_2) INCIDENTS

(Stories provided by Bobby Berrier and are either oral history or personal knowledge)

PROLOGUE

Pertinent to these stories is the fact that 96% (approximate) pure hydrogen peroxide (H_2O_2) was used to simulate hot exhaust flow from propulsion models tested in the 16'TT from the mid 1950's to the late 1960's. [A 3% H_2O_2 solution can be purchased from drug stores and in the 1950's was used by many young people to bleach a strip of their hair white - it usually turned out an ugly shade of yellow]. The 16'TT staff pioneered the use of H_2O_2 for model hot-exhaust propulsion simulation. Liquid H_2O_2 was pumped through the support system into the model. Once inside the model, the H_2O_2 entered a catalyst pack made up of silver screens (much like window screens but much more expensive) cut to the proper radius and compressed into the body of the pack. The silver screen was bought in large rolls and kept under lock and key. A catalyst is a substance that increases the rate of a chemical reaction without itself undergoing any permanent chemical change. In the case of hydrogen peroxide, the silver catalyst decomposes H_2O_2 into superheated steam (H_2O) at approximately 1300°F and oxygen (O). By attaching a tailpipe and nozzle to the back of the catalyst pack, the exhaust from a dry-power turbojet engine can be closely simulated (temperature, gamma, initial plume angle, etc). Although the exhaust simulation is not as good, a gradual change to cold high-pressure air exhaust simulation was made in the late 1960's because of increasing H_2O_2 cost which was used at a prodigious rate.

H_2O_2 of high purity is incompatible with almost all materials except for pure aluminum and some stainless steels. All materials had to be tested for compatibility before coming in contact with H_2O_2. If the H_2O_2 came in contact with a non-compatible material, a slow chemical reaction would start in the best case; instant combustion would result in the worst case (contact with grease or dirt for example). As a result, large water sprinklers with pull chains were mounted on walls at strategic locations close to run operations at building 1146 (16'TT) and building 1234 (JETF) in case personnel came in contact with hydrogen peroxide.

The hydrogen peroxide was purchased by the railroad tank car load and was stored on an isolated railroad siding. As part of my training, I went on a trip to the tank car to pick up a load for model use but my memory does not let me remember the location of the railroad siding. H_2O_2 was transferred from the railroad tank car to a truck with a run tank mounted on it (H_2O_2 trailer) or later to a large tanker truck. A 1955 photograph of the original H_2O_2 trailer with the test crew and 16'TT management (engineering and technicians) is shown in Figure 1.

Figure 1.- Hydrogen peroxide rune tank with test crew (white suits) and management (regular coats). L-R: Roth (technician), Bo Montgomery (technician), John Swihart (engineer), Harry Norton (engineer), Jack Runckel (Asst. Branch Head), Julian Maynard (engineer), Blake Corson (Branch Head), Turner (Head of Technicians?); and Ed Lee (engineer).

It is of interest to note that back then, engineers got their hands dirty as indicated by the protective suits worn by the test crew. It is also of interest to note that John Swihart (third from left in photo) eventually became Vice President of Boeing.

Figures 2 and 3 show the H_2O_2 trailer connected to building 1234 (JETF) where H_2O_2 models were checked out before being installed in the 16'TT. The models were mounded in a trench that could be quickly flooded in case of a H_2O_2 leak.

Side View of H_2O_2 Trailer
Hydrogen Peroxide System for the 16-Foot Tunnel
C-NA1 2323

Figure 2.- H2O2 trailer in front of building 1234.

Front View of H_2O_2 Trailer
Hydrogen Peroxide System for the 16-Foot Tunnel
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Figure 3.- H_2O_2 trailer in front of building 1234.

The large tanker truck that was used later for H_2O_2 transfer from the railroad tank car is shown on the left side of Figure 4. In the photograph, it appears that a H_2O_2 transfer is being made from the tanker truck to the smaller run trailer (with sun shade over top) that is connected through piping to the model installed in the test section. This operation is being conducted underneath the 16-Foot Transonic Tunnel (test section is located above and to the left of the tanker truck).

Figure 4.- Tanker truck and H2O2 run trailer underneath 16-Foot Transonic Tunnel. L-R: Bill Compton (engineer), Mike Taylor (future head of 16'TT technicians), Ben Adderholdt (technician), and Keith Lupton (technician behind barrel).

CHECKING H2O2 TANKS FOR CHEMICAL REACTION

To eliminate the need for frequent trips to a railroad tank car to pick up hydrogen peroxide, two aluminum tanks were constructed near building 1234 (JETF) to store H_2O_2 locally. These tanks are shown in Figure 5. Note the raised concrete perimeter around the tanks to contain any spills or leaks; a drain was located within the perimeter. As previously mentioned, H_2O_2 is unstable if stored in improper containers or comes in contact with even a small amount of contaminate. In this case, a slow chemical reaction is initiated with an attendant release of heat that accelerates the chemical reaction. To detect a chemical reaction starting in the H_2O_2 tanks, thermocouples were installed to measure the temperature of the tanks; the thermocouples were connected to alarms in the heating (steam) plant that was manned 24/7. If one of these temperature alarms was triggered during a 16'TT off-shift or on a weekend, the heating plant had a call list of 16'TT engineers that lived close to the field. Engineers on the list were called until one was found that could come out to the field to check the H_2O_2 tanks. Engineers liked to be on this list since if they were called to come out to check the tanks (less than a five minute procedure), they would earn 2 hours of compensatory leave. Since I lived in Poquoson for a while, I was happy to be on the list. It took me less than 15 minutes to drive to the field. The procedure to check the tanks was to walk up to the tanks and put your hand on them. If they did not feel warm, you reset the alarm and went home. If they felt warm or hot, you opened valves to dump the hydrogen peroxide down the drain (I can't remember now, but some water valves may have also been opened to dilute the hydrogen peroxide). **Do you think the safety office would pitch a hissy fit today?** Either way, I earned 2 hours leave for about 35 minutes of work including travel time.

Figure 5.- H_2O_2 storage tanks in front of building 1234.

<u>F-11F-1 FIRE</u>

As mentioned previously, hydrogen peroxide powered models were usually checked out in the JETF (building 1234) before being installed in the 16'TT for testing. A trench in the JETF, which was equipped with high-flow pumps that could flood the trench with water in case of a H_2O_2 leak, was used for this purpose. Figure 6 shows a photograph of the Grumman F-11F-1 Tiger H_2O_2 propulsion model installed in the trench during checkout.

Figure 6.- Grumman F-11F-1 H_2O_2 propulsion model installed in JETF trench.

A photograph of the Grumman F-11F-1 model installed in the 16-Foot Transonic Tunnel after checkout is shown in Figure 7.

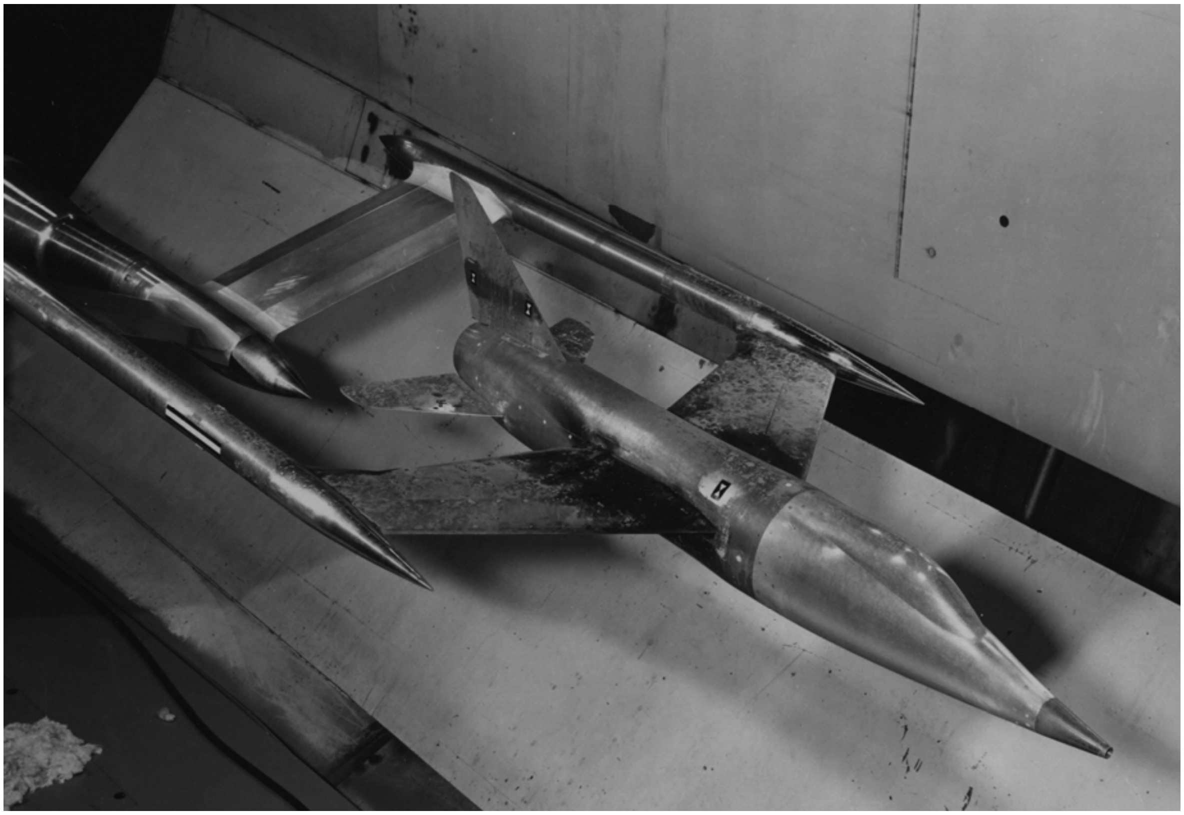

Figure 7.- Grumman F-11F-1 H_2O_2 propulsion model installed in 16'TT.

All hydrogen peroxide models were fabricated with metals that were compatible with H_2O_2. However, some incompatible material (instrumentation leads for example) had to be used because no suitable compatible substitutes existed. In addition, although the models were checked out for H_2O_2 leaks in building 1234 prior to testing, this did not guarantee that problems would not show up in the future. Figure 8 shows what happens when the best laid plans of mice and men go awry. I was not involved with this test so all I know is what you can infer from the photograph but obviously a H_2O_2 leak occurred in the model and the incompatible material caused the H_2O_2 to spontaneously combust. This would certainly ruin your day.

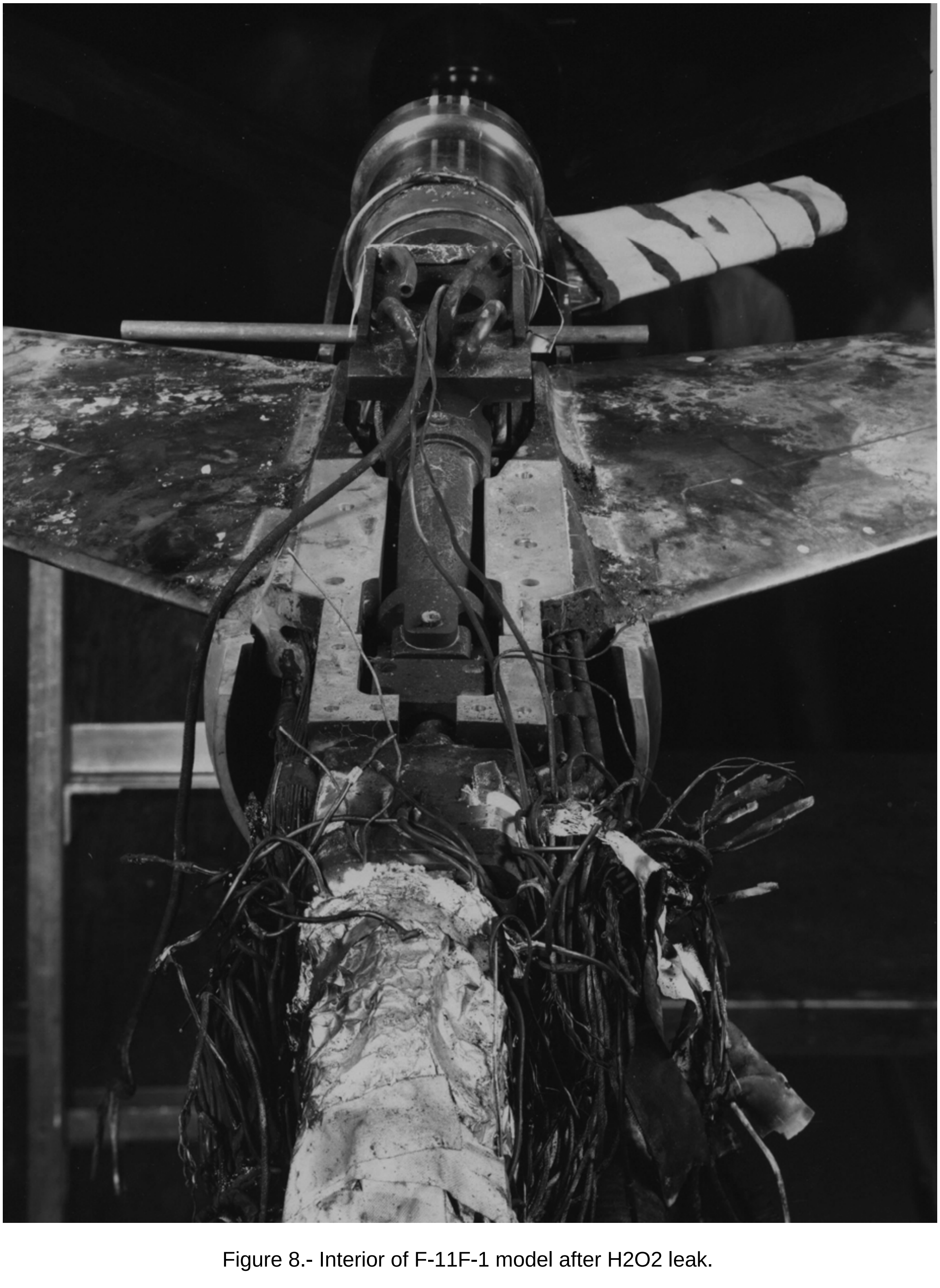

Figure 8.- Interior of F-11F-1 model after H2O2 leak.

PANTS ON FIRE

As mentioned previously, components that were to be used with H_2O_2 were checked for compatibility with the fuel before being used. In addition to model checkout, the trench in building 1234 (described in the previous story) was used for this purpose as well. Small parts (bolts, run valves, etc) were placed in buckets of H_2O_2 and left in the trench for a period of time. The bucket would be checked later to see if a chemical reaction had started. If no chemical reaction was detected, the part was deemed satisfactory for use on the model. Figure 9 presents a photograph of the trench in building 1234 with containers of hydrogen peroxide used for these compatibility checks.

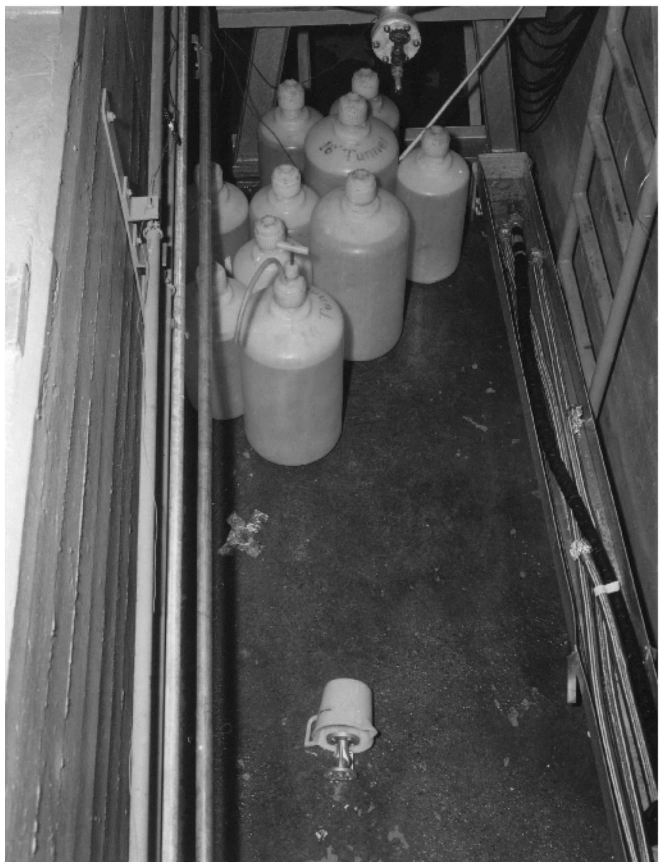

Figure 9.- Photograph of trench in building 1234. Note jugs of H_2O_2.

One day in 1959, a young engineer named Ed Lee (see Figure 1) was checking the compatibility of a model component in a bucket of H_2O_2 down. He started climbing down into the trench using a ladder mounted on the trench sidewall (see Figure 9). Unfortunately, at the bottom of the ladder, he stepped in or on the bucket of H_2O_2 with the model component in it (it can be seen turned over in Figure 9). Before he could climb out of the trench and get to one of the wall-mounted showers, his pants were on fire! A post-incident photograph of his pants is shown in Figure 10. Ed was apparently not harmed to a great extent as he was still at 16'TT when I came to work in 1963.

Figure 10.- Ed Lee's pants after stepping into a bucket of hydrogen peroxide.

PEROXIDE CLOUD

As mentioned previously, silver was the catalyst used for the H_2O_2 decomposition and as such was not chemically altered during the process. However, the melting point of silver is approximately 1700°F while the generated exhaust stream is about 1300°F at the nozzle exit (I don't know the temperature at the point of the H_2O_2/silver interaction but it s certainly higher). Although technically, the silver catalyst pack should not melt, over a period of time the combination of temperature and high-energy gas would gradually eat a hole through the center of the silver catalyst pack (typically about a 0.5 in. H_2O_2 line feeding into the center of an approximately 3 in. diameter silver screen catalyst pack). When this occurred, the hydrogen peroxide would not completely decompose, a condition known as “running wet”, and a cloud of hydrogen peroxide would be expelled from the nozzle exit. During model checkout in the trench of building 1234, a door would be opened behind the model (see Figure 6) and the nozzle exhaust would be directed outside of building 1234. During this process, if the model were “running wet”, a large cloud of atomized hydrogen peroxide would be directed outside. At this time, the wood model shop was located across the street from building 1234 (in what is now, the cafeteria parking lot) and since the shop was not air conditioned, would have large roll doors open during the summer. If the wind was in the right (or should I say wrong) direction, it was not unusual for the 16’TT Branch Head (Blake Corson) to receive a call from the wood shop asking us to stop running in building 1234 because a cloud of hydrogen peroxide had floated across the road and through the open roll doors resulting in everyone’s eyes watering.

<u>APOLLO FIRE</u>

I came to work in June of 1963. The first test that I was assigned to was a test to determine escape rocket operation and command module separation from the service effects on the Apollo Command Module aerodynamics (see Figure 11). At the time of this study (late 1963), I was assigned to dayshift and Odis Pendergraft was assigned to graveyard shift (midnight to 8:00 AM). Liquid H_2O_2 was pumped up the model sting, through the rocket mounting legs on top of the command module, and into the escape rocket body. Inside the rocket body was a silver screen catalyst pack that decomposed the hydrogen peroxide into superheated steam and oxygen to provide a hot exhaust for the escape rocket. During extended running, the rocket nose cone would actually glow red-hot.

I came in to work one morning for my shift and found fire trucks at the tunnel. During night shift, the nose cone had come off of the rocket body allowing the hydrogen peroxide to bypass the catalyst pack and an entire run tank (see Figures 1 and 2) of liquid hydrogen peroxide had been dumped into the tunnel. This not only caused fire in the tunnel but the liquid had run out of any opening in the tunnel to the outside and I was told that a ring of fire was outside on the ground. We had some strange looking technicians for a while after that as the first technicians to enter the tunnel immediately after the incident had their hair bleached white from hydrogen peroxide fumes. It was later found that the rocket nose cone (which screwed onto the rocket body) had been fabricated with fine threads (lots of threads but little thread depth). When the nose cone heated up during rocket operation, it expanded enough to disengage the treads and blow off the front end. The model was modified with course threads (not as many but deeper) and no more problem was experienced with the nose cone.

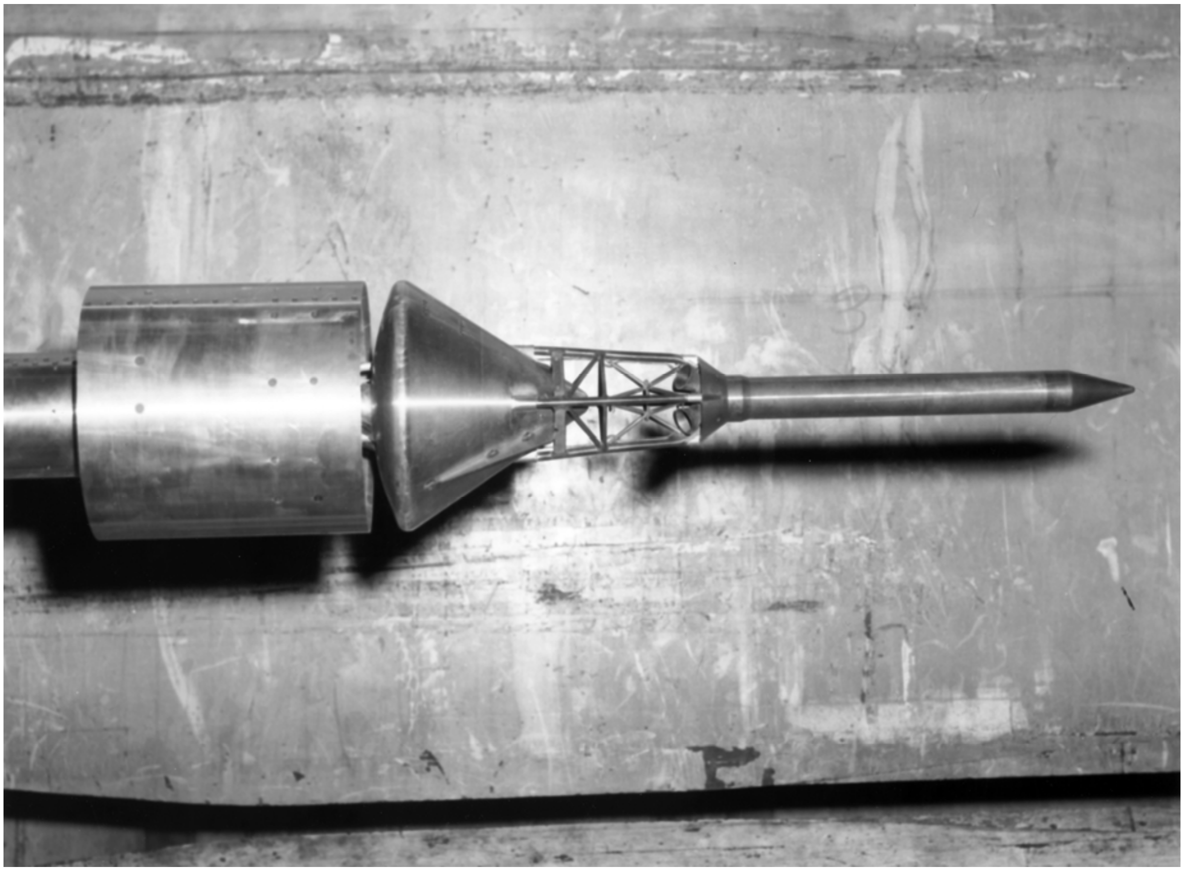

Figure 11.- Apollo command module separation wind tunnel model.

NOTE: For more photos and a few videos on hydrogen peroxide use, see 1146 and 1234.